Tetra Tech EM Inc.

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March 24, 2005

Ms. Lisa Haugen
Work Assignment Manager
U.S. Environmental Protection Agency Region 7
Air, RCRA and Toxics Division
901 North 5th Street
Kansas City, KS 66101

Subject: **Development of Soil Preliminary Remediation Goals**
SECO Products, Washington, Missouri
Contract Number 68-W-02-021, Work Assignment Number R07103

Dear Ms. Haugen:

Tetra Tech EM Inc. (Tetra Tech) is submitting revised soil preliminary remediation goals (PRG) for the SECO Products facility in Washington, Missouri. Tetra Tech developed site-specific PRGs for maintenance and construction workers, and for protection of groundwater. The development followed U.S. Environmental Protection Agency guidance and used professional judgment. Tetra Tech responded to verbal comments received from Mr. Dan Gravatt, site manager.

If you have any questions about these PRGs or require additional information, please call me at (913) 495-3908.

Sincerely,

David Homer
Project Manager

Enclosure

cc: Dan Gravatt, EPA Site Manager
Aaron Zimmerman, EPA Regional Project Officer (letter only)
Ed Sussenguth, Tetra Tech Program Manager (letter only)
Kathy Homer, Tetra Tech Regional Manager (letter only)
File

TECHNICAL MEMORANDUM
SITE-SPECIFIC PRELIMINARY REMEDIATION GOALS
PROTECTION OF HUMAN HEALTH RISK
SECO PRODUCTS
WASHINGTON, MISSOURI

1.0 INTRODUCTION

Tetra Tech EM Inc. (Tetra Tech) received Work Assignment No. R07103 from the U.S. Environmental Protection Agency (EPA) under Contract No. 68-W-02-021 (Resource Conservation and Recovery Act [RCRA] Enforcement and Permitting Assistance) to provide assistance to RCRA staff in EPA Region 7. Under Task 10 of the work assignment, EPA Region 7 has requested that Tetra Tech develop site-specific soil preliminary remediation goals for the SECO Products facility in Washington, Missouri. The objective of the task is to identify soil concentrations that will be protective for current and future use of the facility as industrial property. Tetra Tech met with Mr. Dan Gravatt, on February 1, 2005, to discuss the project and its overall objectives. As a result of that meeting, Mr. Gravatt directed Tetra Tech to develop preliminary remediation goals (PRG) that would be protective for the following receptor populations and exposure pathways:

- Maintenance worker
- Construction worker
- Protection of groundwater from soil releases.

It was also decided that Tetra Tech would not develop PRGs for industrial workers or residential exposures to soils since those values are available from EPA Region 9 PRG tables (EPA 2004).

The SECO Products facility in Washington, Missouri, has documented contamination in the soils and groundwater at the facility. The major contaminant identified is trichloroethene (TCE) and its degradation products cis and trans-1,2-dichloroethylene (DCE) and vinyl chloride (VC). Tetra Tech developed PRGs for only these constituents. Section 2.0 presents the approach taken and assumptions used to calculate PRGs that are protective of maintenance and construction workers. Section 3.0 presents the technical approach used to calculate site-specific PRGs for protection of groundwater from soil releases. References cited in the document are listed in Section 4.0.

2.0 DEVELOPMENT OF PRELIMINARY REMEDIATION GOALS FOR MAINTENANCE AND CONSTRUCTION WORKERS

Tetra Tech followed the general equations for calculations as outlined in EPA's guidance for developing PRGs (EPA 1991 and 2002). These equations identify a number of exposure factors, such as soil ingestion rate, frequence and duration of exposure, inhalation rate, body surface area exposed, and absorption rates. The following table presents these assumptions. Tetra Tech used EPA default values when they were appropriate, site-specific information when available, and professional judgment if no default values or site-specific information was available.

TABLE 1

EXPOSURE FACTORS FOR MAINTENANCE AND CONSTRUCTION WORKERS SECO PRODUCTS

Exposure Factor	Maintenance Worker	Source	Construction Worker	Source
Soil Ingestion Rate (mg/day)	100	EPA 2002	330	EPA 2002
Exposure Duration (yr)	25	EPA 2002	1	EPA 2002
Exposure Frequency (days/yr)	104	Professional Judgment	250	EPA 2002
Surface Area (cm^2)	5,700	EPA 2002	3,300	EPA 2002
Inhalation Rate (m^3/day)	20	EPA 1989	20	EPA 2002
Soil Adherence Factor (mg/cm^2)	0.2	EPA 2002	0.3	EPA 2002
Body Weight (kg)	70	EPA 1989	70	EPA 1989
Lifetime (yr)	70	EPA 1989	70	EPA 1989

Notes:

cm^2	Square centimeter
days/yr	Days per year
kg	Kilogram
m^3/day	Cubic meters per day
mg/cm^2	Milligrams per square centimeter
mg/day	Milligrams per day
yr	Year

Tetra Tech assumed that a maintenance worker's exposure would be similar to an outdoor worker as described in EPA's guidance (EPA 2002); however no guidance is provided on the frequency of exposure for the maintenance worker. Tetra Tech assumed the maintenance worker would be at the facility an average of two days per week conducting various activities such as mowing grass and other outdoor activities. Tetra Tech assumed the maintenance worker would have a similar soil ingestion rate as the outdoor worker described in EPA guidance (EPA 2002).

For the construction worker, Tetra Tech used all the general assumptions provided in EPA's supplemental guidance for developing soil-screening levels (EPA 2002). As noted above, the assumptions Tetra Tech used are consistent with the EPA-recommended default values. Tetra Tech did not include the impacts of fugitive emissions that could occur from construction vehicle traffic, given the size of the site and limited potential significance of this type of exposure.

The calculated maintenance and construction worker soil PRGs for the three chemicals of concern appear below in Table 2; detailed calculations are in Appendix A. The table also includes the EPA Region 9 PRG for industrial soils and residential soils (EPA 2004)

TABLE 2

PRELIMINARY REMEDIATION GOALS
SECO PRODUCTS

Chemical	Preliminary Remediation Goal (µg/kg)			
	Maintenance Worker	Construction Worker	Industrial Worker[1]	Residential[1]
cis-1,2-Dichloroethene	347,853	139,512	150,000	43,000
trans-1,2-Dichloroethene	554,463	224,008	230,000	69,000
Trichloroethene	276	2,756	110	53
Vinyl chloride	1,559	11,376	750	79

Note:
[1] These values derive from EPA 2004.
µg/kg Micrograms per kilogram

3.0 DEVELOPMENT OF SOIL PRELIMINARY REMEDIATION GOALS FOR PROTECTION OF GROUNDWATER

Tetra Tech was also tasked with developing site-specific soil remediation goals that would be protective of groundwater at the SECO Products facility. Tetra Tech calculated screening levels for volatile organic compounds (VOC) identified in shallow soils (0-15 feet below ground surface [bgs]) on site. As noted above, the VOCs of concern are TCE and its daughter products DCE and VC.

Tetra Tech made assumptions about the nature of shallow (0-15 feet bgs) soil based on boring logs and soil cross sections presented in a Site Investigation Summary Report prepared by Environmental Resource Management (ERM) (ERM 2004). From 0-8 feet bgs, soils are generally clayey silt/silty clay. From 8-15 feet bgs extends a well-defined layer of sand (shallow sand aquifer). Depth of these alluvial

layers varies throughout the site; however, for purpose of developing screening levels, the preceding generalizations are acceptable.

Tetra Tech used guidance found in the EPA's Soil Screening Guidance: Technical Background Document (EPA 1996). Section 2.5.2 of this document describes the Organic Compounds-Partition Theory. The following equation is labeled *Soil-Water Partition Equation for Migration to Ground Water Pathway: Organic Contaminants.*

$$C_t = C_w * DAF\left((K_{oc} * f_{oc}) + \frac{\theta_w + \theta_a * H'}{\rho_b} \right) \quad (1)$$

The factors in the equation are defined as follows:

Parameter	Definition	Units
C_t	Screening level in soil	Milligrams per kilogram (mg/kg)
C_w	Target leachate concentration (MCL – chemical-specific)	Milligrams per liter (mg/L)
DAF	Dilution attenuation factor	unitless
K_{oc}	Soil organic carbon-water partition coefficient (chemical-specific)	Liters per kilogram (L/kg)
f_{oc}	Organic Carbon content of soil (default 0.002)	Kg_C per kg_{soil}
θ_w	Water-filled soil porosity (calculated from separate equation)	L_{air}/L_{soil}
θ_a	Air-filled soil porosity (calculated from separate equation)	L_{pore}/L_{soil}
ρ_b	Dry soil bulk density (given for each soil type)	Kilograms per liter (kg/L)
H'	Henry's law constant (chemical-specific)	dimensionless

EPA guidance notes that a dilution attenuation factor (DAF) should be applied to determine the screening level or preliminary remediation goal, since the exposure point to the groundwater is assumed to be away from the source (EPA 1996). The application of the DAF can be based on site condition that include a variety of parameters. The focus on this evaluation is on the soil conditions and therefore, two standard DAFs – 1 and 20 will be used in the calculations.

Chemical-Specific Benchmarks

The following factors C_w, K_{oc}, and H' are given for each contaminant of concern (COC) and are listed in the guidance:

Chemical	C_w (mg/L)		K_{oc} (L/kg)	H' (dimensionless)	MCL (mg/L)
	DAF 1	DAF 20			
1,2-Dichloroethene (total)	0.07	1.4	3.8 E+01	2.76 E-01	0.07
Trichloroethene	0.005	0.1	9.4 E+01	4.22 E-01	0.005
Vinyl chloride	0.002	0.04	1.86 E+01	1.11 E+00	0.002

Sources:

C_w – For a dilution attenuation factor (DAF) the Maximum Contaminant Levels (MCL) in mg/L were used for the target leachate concentrations (EPA 2005). To determine the C_w value for a DAF of 20 the MCL was multiplied by 20 as specified in the guidance (EPA 1996).

K_{oc} – Table 38 (EPA 1996) listed measured soil organic carbon-water partition coefficient (K_{oc}) values for nonionizing organics. The average value was used for each COC.

H' – Table 36 (EPA 1996) listed chemical-specific properties used in SSL calculations. Henry's law constant was here given for each COC. For 1,2-Dichloroethene the cis and trans values were averaged to determine a Henry's law constant for total DCE.

Soil-Specific Benchmarks

The following factors are given for each soil type: f_{oc}, ρ_b, θ_w, and θ_a.

- f_{oc} – No information was available to determine the organic carbon content of the site soil; therefore, the default value of 0.002 (kg/kg) (0.2%) was used (EPA 1996).
- ρ_b – Dry bulk density was listed for 12 soil textural classifications on page 19 of the *User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings* (EPA 2003).
- θ_a – Air-filled soil porosity was calculated by subtracting θ_W from θ_t (both defined below).
- θ_w – Water-filled soil porosity (average long-term volumetric soil moisture content) was calculated using an equation found in Guideline for Predictive Baseline Emissions Estimate for Superfund Sites (EPA 1995). On page 15 of this document, the following equation was cited to determine θ_w:

$$\theta_w = \theta_t \left(I / K_s\right)^{1/(2b+3)} \quad (2)$$

Parameter	Definition	Units
θ_w	Average long-term volumetric soil moisture content	L_{water}/L_{soil}
θ_t	Total soil porosity	Unitless
I	Average water infiltration rate	Meters per year (m/yr)
K_s	Soil-saturated hydraulic conductivity	m/yr
1/(2b+3)	Soil-specific exponential parameter	Unitless

θ_t – The total soil porosity (labeled *n* in [EPA 1996]), was calculated using the following equation (EPA 1995):

$$\theta_t = 1 - (\rho_b / \rho_s) \quad (3)$$

ρ_s – No site-specific information was available for soil particle density (ρ_s); therefore, the default value of 2.65 kg/L was used (EPA 1995).

I – Average water infiltration rates were available in Appendix A in EPA 1995. The site was assumed in the "Glaciated Central Region" in an area of "Till over Bedded Sedimentary Rock." The average recharge rate was used for the calculations (0.14 m/yr).

K_s – Soil-saturated hydraulic conductivity was given by soil texture in Table 1 in EPA 1995.

1/(2b+3) – The soil-specific exponential parameter was given by soil texture in Table 1 in EPA 1995.

Results

PRGs for protection of groundwater were developed using the method described above, the detailed calculations are provided in Appendix B. The resulting PRGs for the two DAF assumptions are as follows:

Soil Type	Preliminary Remediation Goals – Protection of Groundwater (mg/kg)					
	Trichloroethene		Total Dichloroethene		Vinyl chloride	
	DAF 1	DAF 20	DAF 1	DAF 20	DAF 1	DAF 20
Silty Clay	2.52E-3	5.05 E-02	2.69E-2	5.38 E-01	7.81E-4	1.56 E-02.
Sand	1.70E-3	3.39 E-02	1.45E-2	2.91 E-01	5.53E-4	1.11 E-02

4.0 REFERENCES

Environmental Resources Management (ERM). 2004. Site Investigation Summary Report. SECO Products Facility. Washington, Missouri. October 11.

U.S. Environmental Protection Agency (EPA). 1989. *Risk Assessment Guidance for Superfund* (RAGS). Volume I: Human Health Evaluation Manual (Part A). Interim Final. Office of Emergency and Remedial Response (OERR). Washington, D.C. EPA/540/1-89/002. December.

EPA. 1991. *Risk Assessment Guidance for Superfund* (RAGS). Volume I: Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Interim Final. Office of Emergency and Remedial Response (OERR). Washington, DC. EPA/540/R-92/003. December.

EPA. 1995. Air/Superfund National Technical Guidance Study Series. Guidelines for Predictive Baseline Emissions Estimation for Superfund Sites. Interim Final. Office of Air Quality. EPA-451/R-96-001. November

EPA. 1996. Soil Screening Guidance: Technical Background Document. Office of Solid Waste and Emergency Response. Washington, D.C. EPA/540/R-95/12. May

EPA. 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. Solid Waste and Emergency Response. OSWER 9355.4-24. December.

EPA. 2003. *User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings.* Office of Emergency and Remedial Response. June

EPA. 2004. "Region 9 PRGs Table 2004 Update." October 4. On-line Address: http://www.epa.gov/region09/waste/sfund/prg/whatsnew.htm.

APPENDIX A

CALCULATION OF SOIL PRELIMINARY REMEDIATION GOALS

MAINTENANCE WORKER
AND
CONSTRUCTION WORKER

TABLE A-1

SOIL PRELIMIINARY REMEDIATION GOALS
CARCINOGENIC CHEMICALS
SECO PRODUCTS
MAINTENANCE WORKER
SITE-SPECIFIC ASSUMPTIONS

COPC	$SF_{inhalation}$	SF_{oral}	1/VF (m^3/kg)	VF	ABS	(EF x ED)/ (BW x ATcarc)	INGESTION (SFo x FI x IRS x EF x ED x MCF)/ (BW x ATcarc)	DERMAL (SFo x SA x AF x ABS x EF x ED x MCF)/ (BW x ATcarc)	INHALATION [SFi x (1/PEF +1/VF) x IR x EF x ED]/ BW x ATcarc		**TOTAL EPCsoil (ug/kg)**
cis-1,2-Dichloroethene	--	--	3.45E-04	2.90E+03	0.10	1.45E-03	--	--	--	(a)	--
trans-1,2-Dichloroethene	--	--	4.35E-04	2.30E+03	0.10	1.45E-03	--	--	--	(a)	--
Trichloroethylene (TCE)	4.0E-01	4.0E-01	3.03E-04	3.30E+03	0.10	1.45E-03	5.81E-08	3.84E-08	3.52E-06	(a)	2.8E+02
Vinyl chloride	1.6E-02	7.3E-01	1.00E-03	1.00E+03	0.10	1.45E-03	1.06E-07	7.00E-08	4.65E-07	(a)	1.6E+03

Notes:
(a) Used 1/VF in calculations instead of 1/PEF

MAINTENANCE WORKER ASSUMPTIONS		Ingestion			Dermal		Inhalation	
BW (kg)	70	FI (unitless)	1		SA (cm2/day)	3,300	IR (m^3/day)	20
ATcarc (days)	25,550	IRS (mg/day)	100		AF (mg/cm2)	0.2	1/PEF (m^3/kg)	1.88E-07
EF (days/year)	104	MCF (kg/mg)	1.00E-06		MCF (kg/mg)	1.00E-06		
ED (years)	25	--						

EPA defaults used with the exception of PEF and EF which used site specific information

Legend:

SF=Slope Factor
VF=Volatization Factor
ABS=Absorption Factor
EF=Exposure Frequency
ED=Exposure Duration
BW=Body Weight
FI=Fraction Ingestion
MCF=Mass Conversion Factor
PEF=Particulate Emission Factor
AT=Averaging Time
SA=Surface Area
AF=Adherence Factor
IR=Inhalation Rate
IRS=Ingestion Rate Soil
kg = kilogram
mg/day = milligram per day
mg/cm^2 = milligram per square centimeter
kg/mg = kilogram per milligram
m^3/day = cubic meters per day
m3/kg = cubic meters per kilogram

TABLE A-2

SOIL PRELIMINARY REMEDIATION GOALS
NONCARCINOGENIC CHEMICALS
SECO PRODUCTS
MAINTENANCE WORKER
SITE-SPECIFIC ASSUMPTIONS

Analyte	RfD_{oral}	$RfD_{inhalation}$	ABS	1/VF	VF	(ED x EF)/ (BW x ATnon)	INGESTION (FI x IRS x MCF)/ RfDo	DERMAL (SA x AF x ABS x MCF)/ RfDo	INHALATION [(1/PEF + 1/VF) x IR]/ RfDi		TOTAL EPCsoil $(M \times G)^{-1}$ (ug/kg)
cis-1,2-Dichloroethene	1.0E-02	1.0E-02	0.10	3.45E-04	2.90E+03	4.07E-03	1.00E-02	6.60E-03	6.90E-01	(a)	3.5E+05
trans-1,2-Dichloroethene	2.0E-02	2.0E-02	0.10	4.35E-04	2.30E+03	4.07E-03	5.00E-03	3.30E-03	4.35E-01	(a)	5.5E+05
Trichloroethylene (TCE)	6.0E-03	6.0E-03	0.10	3.03E-04	3.30E+03	4.07E-03	1.67E-02	1.10E-02	1.01E+00	(a)	2.4E+05
Vinyl chloride	3.0E-03	2.9E-02	0.10	1.00E-03	1.00E+03	4.07E-03	3.33E-02	2.20E-02	6.90E-01	(a)	3.3E+05

Notes:

(a) Used 1/VF in calculations instead of 1/PEF

MAINTENANCE WORKER ASSSUMPTIONS		Ingestion			Dermal		Inhalation	
BW (kg)	70	FI (unitless)	1		SA (cm^2/day)	3,300	IR (m^3/day)	20
ATnon (days)	9,125	IRS (mg/day)	100		AF (mg/cm^2)	0.2	1/PEF (m^3/kg)	1.88E-07
EF (days/year)	104	MCF (kg/mg)	1.00E-06		MCF (kg/mg)	1.00E-06		
ED (years)	25	--						

EPA defaults used with the exception of PEF and EF which used site specific information

Legend:
RFD=Reference Dose MCF=Mass Conversion Factor kg = kilogram

TABLE A-3

SOIL PRELIMINARY REMEDIATION GOALS
SECO PRODUCTS
MAINTENANCE WORKER
SITE-SPECIFIC ASSUMPTIONS

Analyte	Cancer PRG Level (ug/kg)	Noncancer PRG Level (ug/kg)	PRG Level (ug/kg)	Basis of Target Cleanup Level
Organics				
cis-1,2-Dichloroethene	--	347,853.1	347,853.1	Noncancer
trans-1,2-Dichloroethene	--	554,463.4	554,463.4	Noncancer
Trichloroethylene (TCE)	276.2	236,732.2	276.2	Cancer
Vinyl chloride	1,559.2	329,767.6	1,559.2	Cancer

Legend:
PRG=Preliminary Remediation Goal

Table A-4

Soil Preliminary Remediation Goals
Carcinogenic Chemicals
Seco Products
Construction Worker
Site Specific Assumptions

COPC	$SF_{inhalation}$	SF_{oral}	1/VF (m^3/kg)	VF	ABS	(EF x ED)/ (BW x ATcarc)	INGESTION (SFo x FI x IRS x EF x ED x MCF)/ (BW x ATcarc)	DERMAL (SFo x SA x AF x ABS x EF x ED x MCF)/ (BW x ATcarc)	INHALATION [SFi x (1/PEF +1/VF) x IR x EF x ED]/ BW x ATcarc		**TOTAL EPCsoil (ug/kg)**
cis-1,2-Dichloroethene	--	--	3.45E-04	2.90E+03	0.10	1.40E-04	--	--	--	(a)	--
trans-1,2-Dichloroethene	--	--	4.35E-04	2.30E+03	0.10	1.40E-04	--	--	--	(a)	--
Trichloroethylene (TCE)	4.0E-01	4.0E-01	3.03E-04	3.30E+03	0.10	1.40E-04	1.85E-08	5.54E-09	3.39E-07	(a)	2.8E+03
Vinyl chloride	1.6E-02	7.2E-01	1.00E-03	1.00E+03	0.10	1.40E-04	3.32E-08	9.96E-09	4.47E-08	(a)	1.1E+04

Notes:
(a) Used 1/VF in calculations instead of 1/PEF

MAINTENANCE WORKER ASSUMPTIONS		Ingestion			Dermal		Inhalation	
BW (kg)	70	FI (unitless)	1		SA (cm2/day)	3,300	IR (m^3/day)	20
ATcarc (days)	25,550	IRS (mg/day)	330		AF (mg/cm2)	0.3	1/PEF (m^3/kg)	1.88E-07
EF (days/year)	250	MCF (kg/mg)	1.00E-06		MCF (kg/mg)	1.00E-06		
ED (years)	1	--						

EPA defaults used with the exception of PEF which used site specific information

Legend:

SF=Slope Factor
VF=Volatization Factor
ABS=Absorption Factor
EF=Exposure Frequency
ED=Exposure Duration
BW=Body Weight
FI=Fraction Ingestion
MCF=Mass Conversion Factor
PEF=Particulate Emission Factor
AT=Averaging Time
SA=Surface Area
AF=Adherence Factor
IR=Inhalation Rate
IRS=Ingestion Rate Soil
kg = kilogram
mg/day = milligram per day
mg/cm^2 = milligram per square centimeter
kg/mg = kilogram per milligram
m^3/day = cubic meters per day
m3/kg = cubic meters per kilogram

Table A-5

Soil Preliminary Remediation Goals
Noncarcinogenic Chemicals
Seco Products
Construction Worker
Site Specific Assumptions

Analyte	RfD_{oral}	$RfD_{inhalation}$	ABS	1/VF	VF	(ED x EF)/ (BW x ATnon)	INGESTION (FI x IRS x MCF)/ RfDo	DERMAL (SA x AF x ABS x MCF)/ RfDo	INHALATION [(1/PEF + 1/VF) x IR]/ RfDi		TOTAL EPCsoil $(M \times G)^{-1}$
											(ug/kg)
cis-1,2-Dichloroethene	1.0E-02	1.0E-02	0.10	3.45E-04	2.90E+03	9.78E-03	3.30E-02	9.90E-03	6.90E-01	(a)	1.4E+05
trans-1,2-Dichloroethene	2.0E-02	2.0E-02	0.10	4.35E-04	2.30E+03	9.78E-03	1.65E-02	4.95E-03	4.35E-01	(a)	2.2E+05
Trichloroethylene (TCE)	6.0E-03	6.0E-03	0.10	3.03E-04	3.30E+03	9.78E-03	5.50E-02	1.65E-02	1.01E+00	(a)	9.4E+04
Vinyl chloride	3.0E-03	2.9E-02	0.10	1.00E-03	1.00E+03	9.78E-03	1.10E-01	3.30E-02	6.90E-01	(a)	1.2E+05

Notes:

(a) Used 1/VF in calculations instead of 1/PEF

MAINTENANCE WORKER ASSSUMPTIONS			Ingestion		Dermal		Inhalation	
	BW (kg)	70	FI (unitless)	1	SA (cm^2/day)	3,300	IR (m^3/day)	20
	ATnon (days)	365	IRS (mg/day)	330	AF (mg/cm^2)	0.3	1/PEF (m^3/kg)	1.88E-07
	EF (days/year)	250	MCF (kg/mg)	1.00E-06	MCF (kg/mg)	1.00E-06		
	ED (years)	1	--					

EPA defaults used with the exception of PEF which used site specific information

Legend:
RFD=Reference Dose MCF=Mass Conversion Factor kg = kilogram

Table A-6

Soil Preliminary Remediation Goals
Seco Products
Construction Worker
Site Specific Assumptions

Analyte	Cancer PRG Level (ug/kg)	Noncancer PRG Level (ug/kg)	PRG Level (ug/kg)	Basis of Target Cleanup Level
Organics				
cis-1,2-Dichloroethene	--	139,511.7	139,511.7	Noncancer
trans-1,2-Dichloroethene	--	224,008.5	224,008.5	Noncancer
Trichloroethylene (TCE)	2,755.9	94,489.6	2,755.9	Cancer
Vinyl chloride	11,375.8	122,739.9	11,375.8	Cancer

Legend:
PRG Preliminary Remediation Goal
ug/kg microgram per kilogram

APPENDIX B

CALCULATION OF SOIL PRELIMINARY REMEDIATION GOALS

PROTECTION OF GROUNDWATER

TABLE B-1

CALCULATION OF WATER FILLED POROSITY FOR
SOILS AT SECO PRODUCTS

SILTY CLAY (0-8')

Parameter	*Defenition (units)*	*Value*
I	Average water infiltration rate (m/yr)	0.14
Ks	Soil saturated hydraulic conductivity (m/yr)	8
1/(2b+3)	Soil-specific exponential parameter (unitless)	0.042
ρ_s	True soil or particle density (kg/L_{soil}) (default = 2.65 kg/L)	2.65
ρ_b	Average soil dry buld density (kg/L_{soil})	1.38
θ_t	Total soil porosity (unitless)	0.479245283
θ_w	Average long-term volumetric soil moisture content (L_{water}/L_{soil})	**0.404357446**

SAND (8-15')

Parameter	*Defenition (units)*	*Value*
I	Average water infiltration rate (m/yr)	0.14
Ks	Soil saturated hydraulic conductivity (m/yr)	1830
1/(2b+3)	Soil-specific exponential parameter (unitless)	0.09
ρ_s	True soil or particle density (kg/L_{soil}) (default = 2.65 kg/L)	2.65
ρ_b	Average soil dry buld density (kg/L_{soil})	1.66
θ_t	Total soil porosity (unitless)	0.374
θ_w	Average long-term volumetric soil moisture content (L_{water}/L_{soil})	**0.159**

Note:

The following equations were used to calculate total porosity (θ_t) and water-filled porosity (θ_w).

$$\theta_t = 1 - \left(\rho_b / \rho_s\right)$$

$$\theta_w = \theta_t \left(I / K_s\right)^{1/(2b+3)}$$

TABLE B-2

SOIL PRELIMINARY REMEDIATION GOALS
PROTECTION OF GROUNDWATER
DILUTION ATTENUATION FACTOR - 1
SECO PRODUCTS

VINYL CHLORIDE

Parameter	*Defenition (units)*	*Value*
C_W	Target soil leachate concentration (mg/L)	0.002
H'	Henry's law constant (dimensionless)	1.11
K_{OC}	Soil organic carbon-water partition coefficient (L/kg)	18.6

TRICHLOROETHYLENE

Parameter	*Defenition (units)*	*Value*
C_W	Target soil leachate concentration (mg/L)	0.005
H'	Henry's law constant (dimensionless)	0.422
K_{OC}	Soil organic carbon-water partition coefficient (L/kg)	94.3

1,2-DICHLOROETHENE (CIS AND TRANS)

Parameter	*Defenition (units)*	*Value*
C_W	Target soil leachate concentration (mg/L)	0.07
H'	Henry's law constant (dimensionless)	0.276
K_{OC}	Soil organic carbon-water partition coefficient (L/kg)	38.0

SILTY CLAY (0-8')

Parameter	*Defenition (units)*	*Value*
f_{oc}	Organic carbon content of soil (kg/kg) (default = 0.002)	0.002
θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.404
θ_a	Air-filled soil porosity (L_{air}/L_{soil})	0.075
ρ_b	Dry soil bulk density (kg/L)	1.38

SAND (8-15')

Parameter	*Defenition (units)*	*Value*
f_{oc}	Organic carbon content of soil (kg/kg) (default = 0.002)	0.002
θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.159
θ_a	Air-filled soil porosity (L_{air}/L_{soil})	0.214
ρ_b	Dry soil bulk density (kg/L)	1.66

Preliminary Remediation Goals

C_t *(mg/kg)*	*Vinyl Chloride*	*Trichloroethene*	*1,1-Dichloroethene*
Silty Clay (0-8')	7.81E-04	2.52E-03	2.69E-02
Sand (8-15')	5.53E-04	1.70E-03	1.45E-02

Note:
Equation used to calculate the soil screening level for the protection of groundwater is given below (EPA 1996)

$$C_t = C_w \left(\left(K_{oc} * f_{oc} \right) + \frac{\theta_w + \theta_a * H'}{\rho_b} \right)$$

TABLE B-1

CALCULATION OF WATER FILLED POROSITY FOR
SOILS AT SECO PRODUCTS

SILTY CLAY (0-8')

Parameter	*Defenition (units)*	*Value*
I	Average water infiltration rate (m/yr)	0.14
Ks	Soil saturated hydraulic conductivity (m/yr)	8
1/(2b+3)	Soil-specific exponential parameter (unitless)	0.042
ρ_s	True soil or particle density (kg/L_{soil}) (default = 2.65 kg/L)	2.65
ρ_b	Average soil dry buld density (kg/L_{soil})	1.38
θ_t	Total soil porosity (unitless)	0.479245283
θ_w	Average long-term volumetric soil moisture content (L_{water}/L_{soil})	**0.404357446**

SAND (8-15')

Parameter	*Defenition (units)*	*Value*
I	Average water infiltration rate (m/yr)	0.14
Ks	Soil saturated hydraulic conductivity (m/yr)	1830
1/(2b+3)	Soil-specific exponential parameter (unitless)	0.09
ρ_s	True soil or particle density (kg/L_{soil}) (default = 2.65 kg/L)	2.65
ρ_b	Average soil dry buld density (kg/L_{soil})	1.66
θ_t	Total soil porosity (unitless)	0.374
θ_w	Average long-term volumetric soil moisture content (L_{water}/L_{soil})	**0.159**

Note:

The following equations were used to calculate total porosity (θ_t) and water-filled porosity (θ_w).

$$\theta_t = 1 - \left(\rho_b / \rho_s\right)$$

$$\theta_w = \theta_t \left(I / K_s\right)^{1/(2b+3)}$$

TABLE B-2

SOIL PRELIMINARY REMEDIATION GOALS
PROTECTION OF GROUNDWATER
DILUTION ATTENUATION FACTOR - 1
SECO PRODUCTS

VINYL CHLORIDE

Parameter	*Defenition (units)*	*Value*
C_W	Target soil leachate concentration (mg/L)	0.002
H'	Henry's law constant (dimensionless)	1.11
K_{OC}	Soil organic carbon-water partition coefficient (L/kg)	18.6

TRICHLOROETHYLENE

Parameter	*Defenition (units)*	*Value*
C_W	Target soil leachate concentration (mg/L)	0.005
H'	Henry's law constant (dimensionless)	0.422
K_{OC}	Soil organic carbon-water partition coefficient (L/kg)	94.3

1,2-DICHLOROETHENE (CIS AND TRANS)

Parameter	*Defenition (units)*	*Value*
C_W	Target soil leachate concentration (mg/L)	0.07
H'	Henry's law constant (dimensionless)	0.276
K_{OC}	Soil organic carbon-water partition coefficient (L/kg)	38.0

SILTY CLAY (0-8')

Parameter	*Defenition (units)*	*Value*
f_{oc}	Organic carbon content of soil (kg/kg) (default = 0.002)	0.002
θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.404
θ_a	Air-filled soil porosity (L_{air}/L_{soil})	0.075
ρ_b	Dry soil bulk density (kg/L)	1.38

SAND (8-15')

Parameter	*Defenition (units)*	*Value*
f_{oc}	Organic carbon content of soil (kg/kg) (default = 0.002)	0.002
θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.159
θ_a	Air-filled soil porosity (L_{air}/L_{soil})	0.214
ρ_b	Dry soil bulk density (kg/L)	1.66

Preliminary Remediation Goals

C_t *(mg/kg)*	*Vinyl Chloride*	*Trichloroethene*	*1,1-Dichloroethene*
Silty Clay (0-8')	7.81E-04	2.52E-03	2.69E-02
Sand (8-15')	5.53E-04	1.70E-03	1.45E-02

Note:
Equation used to calculate the soil screening level for the protection of groundwater is given below (EPA 1996)

$$C_t = C_w \left(\left(K_{oc} * f_{oc} \right) + \frac{\theta_w + \theta_a * H'}{\rho_b} \right)$$

TABLE B-3

SOIL PRELIMINARY REMEDIATION GOAL
PROTECTION OF GROUNDWATER
DILUTION ATTENUATION FACTOR - 20
SECO PRODUCTS

VINYL CHLORIDE

Parameter	*Defenition (units)*	*Value*
C_W	Target soil leachate concentration (mg/L)	0.04
H	Henry's law constant (dimensionless)	1.11
K_{OC}	Soil organic carbon-water partition coefficient (L/kg)	18.6

TRICHLOROETHYLENE

Parameter	*Defenition (units)*	*Value*
C_W	Target soil leachate concentration (mg/L)	0.1
H	Henry's law constant (dimensionless)	0.422
K_{OC}	Soil organic carbon-water partition coefficient (L/kg)	94.3

1,2-DICHLOROETHENE (CIS AND TRANS)

Parameter	*Defenition (units)*	*Value*
C_W	Target soil leachate concentration (mg/L)	1.4
H	Henry's law constant (dimensionless)	0.276
K_{OC}	Soil organic carbon-water partition coefficient (L/kg)	38.0

SILTY CLAY (0-8')

Parameter	*Defenition (units)*	*Value*
f_{oc}	Organic carbon content of soil (kg/kg) (default = 0.002)	0.002
θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.404
θ_a	Air-filled soil porosity (L_{air}/L_{soil})	0.075
ρ_b	Dry soil bulk density (kg/L)	1.38

SAND (8-15')

Parameter	*Defenition (units)*	*Value*
f_{oc}	Organic carbon content of soil (kg/kg) (default = 0.002)	0.002
θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.159
θ_a	Air-filled soil porosity (L_{air}/L_{soil})	0.214
ρ_b	Dry soil bulk density (kg/L)	1.66

Preliminary Remediation Goals

C_t *(mg/kg)*	*Vinyl Chloride*	*Trichloroethene*	*Total Dichloroethene*
Silty Clay (0-8')	1.56E-02	5.05E-02	5.38E-01
Sand (8-15')	1.11E-02	3.39E-02	2.91E-01

Note:
Equation used to calculate the soil screening level for the protection of groundwater is given below (EPA 1996)

$$C_t = C_w \left(\left(K_{oc} * f_{oc} \right) + \frac{\theta_w + \theta_a * H'}{\rho_b} \right)$$